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ORIGINAL ARTICLE

Body mass index and age are predictors for symptom improvement after high-power laser vaporization for benign prostatic hyperplasia

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KEYWORDS
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predictor;
subgroup

Background/Purpose: To evaluate the effectiveness and safety of high-power 120W Greenlight HPS laser (HPS) and compare the results to transurethral resection of the prostate (TURP), and define a subgroup of patients who had better symptom score improvement after HPS.

Methods: One hundred and twenty-five patients who underwent surgery for benign prostatic hyperplasia (BPH) (61 HPS and 64 TURP) were retrospectively followed. Improvements of International Prostate Symptom Score (IPSS), quality of life score (QoL), maximum flow rate (Qmax) and post-void residual (PVR) were assessed at 4 weeks after the procedures. Potential covariates including age, body mass index (BMI), prostate volume (PV) and serum prostate-specific antigen (PSA) were defined and further subgroup analyses were utilized.

Results: The HPS group had a significantly higher education level, annual household income and larger prostate size. Compared with TURP, HPS resulted in comparable IPSS, QoL, Qmax and PVR improvements, but shorter hospitalization duration, serum hemoglobin loss and blood transfusion rate. Subgroup analyses showed that men in the HPS group were younger (age < 76 years), had higher BMI ($\geq 24\ kg/m^2$) and greater adjusted IPSS and QoL improvements than men in the TURP group.

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Conclusion: HPS offered adequate effectiveness for symptomatic BPH versus TURP and was advantageous with regard to operative safety. Patients who are younger and have higher BMI may achieve better improvements with HPS than with TURP. Further long-term follow-up study is warranted.

Introduction

Transurethral resection of the prostate (TURP) has been the most commonly used procedure for benign prostatic hyperplasia (BPH) with apparently subjective and objective improvements,[1] but the associated bleeding and high complication rates restrict the applications to a selected population.[2,3]

The photoselective vaporization (PVP) with potassium-titanyl-phosphate (KTP) laser was established as a useful and safe alternative for symptomatic BPH.[4–7] The more powerful 120W Greenlight HPS laser (HPS) was developed recently to utilize a higher rate of energy and improve efficacy,[8–10] but the evidence for which subgroup will benefit more from HPS is scarce.[11]

In this study, we assessed the outcomes of men with symptomatic BPH after utilization of the HPS, compared the results to TURP, and defined a potential subgroup of patients that would have more symptom score improvement after HPS.

Materials and methods

Participants

From January 2007 to December 2009, 125 men with symptomatic BPH who underwent either HPS or TURP were retrospectively followed. The protocol was approved by the hospital ethics committee and informed consent was obtained from all patients. Inclusion criteria for the study were International Prostate Symptom Score (IPSS) greater than 7, Qmax less than 15 mL/s or acute urinary retention. Patients who had prostate cancer, prior prostatic or urethral surgery, or bladder tumor were excluded from the study. Men taking anticoagulants maintained medication before and after HPS during hospitalization, while TURP patients stopped taking the drugs for at least 1 week. There were 61 men enrolled in the HPS group and 64 in the TURP group. Most procedures were performed under spinal anesthesia.

Basic data such as age, height and weight were collected. The education level of the patients and annual household income were recorded by special nurses at admission. Validated IPSS and quality of life score (QoL) questionnaires were completed. Uroflowmetry was performed and baseline maximum flow rate (Qmax) and post-void residual urine (PVR) were also evaluated. Biochemical assessments were done as follows: urine analysis, serum sodium, hemoglobin and prostate-specific antigen (PSA) level. Prostate volume (PV) was evaluated using transrectal ultrasound (TRUS) measurement. The American Society of Anesthesiologists (ASA) score for each patient was calculated by an experienced anesthesiologist. High operation risk was defined as patients with an ASA score greater than 2 and/or taking anticoagulants or with a bleeding tendency. In patients with elevated PSA level or abnormal digital rectal examination TRUS-guided biopsies were performed.

Standard TURP was performed by using the 26F continuous-flow monopolar resectoscope. A 22F three-way Foley urethral catheter was left in place postoperatively. HPS was performed with a 120W (The Greenlight HPS) laser generator with the laser energy delivered by a side-firing fiber through a 24F continuous-flow cystoscope. The energy was absorbed by hemoglobin in the prostate tissue, and it vaporized the prostate tissue and ended with a wide-opened TURP-like cavity.

Serum sodium and hemoglobin level were collected again within 4 hours postoperation. Hospitalization duration was defined as between the time between admission day (1 day before operation) and the discharge day and was recorded by a special nurse. Four functional outcomes including IPSS, QoL, Qmax and PVR improvements were evaluated 4 weeks later in urology clinics.

Statistics

Continuous variables were analyzed with the Student *t* test and are presented as mean $\pm$ standard deviation (SD). Categorical variables were analyzed with the Chi-square test and are recorded as frequency or percentage. The two-sided alpha level was 0.05. A p value of less than 0.05 was considered to be statistically significant. A general linear model was used for detailed clinical covariate adjustments and four covariates including age, BMI, PV, and PSA were presented for subgroup analysis, with the median value as the cut-off point for each group. All statistical calculation was performed using SAS Version 9.1 (SAS Institute, Cary, NC) and STATA Version 10.0 (Stata Corporation, College Station, Texas) was used for figures of box plots.

As for sample size determination, according to previous studies, IPSS improvement greater than 4.9 was considered significantly different.[12] We set IPSS improvement as 5, within group standard deviation as 7, alpha level 0.05 and power value of 0.8, and the estimated sample size as 43 in each group.

Results

The baseline characteristics for both groups are listed in Table 1. Compared with the TURP group, HPS patients had a significantly higher education level, household income and larger prostate size. Twenty-one HPS patients (34%)

Table 1 Preoperative demographics for patients receiving treatment with 120W Greenlight HPS laser (HPS) or transurethral resection of the prostate (TURP).

	HPS	TURP	*p*
	n = 61	*n* = 64	
Age (y)	74.1 ± 9.76 (50–99)	76.1 ± 7.74 (55–89)	0.21
Height (cm)	166 ± 6.31 (140–180)	164 ± 6.87 (150–178)	0.17
Weight (kg)	65.9 ± 9.60 (44–89)	62.4 ± 10.6 (40–83)	0.06
Body mass index (kg/m^2)	24.0 ± 3.09 (16.2–30.8)	23.3 ± 3.55 (15.2–31.3)	0.26
Prostate volume (g)	60.9 ± 26.1 (25–136)	51.6 ± 23.4 (20–101)	0.04
Prostate-specific antigen (ng/mL)	7.48 ± 10.4 (0.4–29.1)	6.81 ± 5.12 (0.3–19.8)	0.70
IPSS	19.5 ± 6.32 (11–35)	21.4 ± 7.00 (8–35)	0.14
Postvoided residual (mL)	208 ± 200 (0–800)	190 ± 217 (35–950)	0.64
Maximum uroflow (mL/second)	9.86 ± 3.45 (2.5–13.5)	9.41 ± 3.64 (1.5–13.5)	0.56
Quality of life score	4.61 ± 0.77 (2–6)	4.48 ± 1.01 (2–6)	0.44
Anesthesia score	2.14 ± 0.59 (1–3)	2.29 ± 0.61 (1–3)	0.20
Socioeconomic status			
Education (%)			0.002
Elementary school or less	32	53	
High school	27	27	
College	41	20	
Household income[a]			0.01
Low	24	6	
Averaged	16	8	
High	60	86	

Numeric data are expressed as means ± SD and compared with the *t* test. Categorical data are expressed as numbers (percentage) and compared with the Chi-square test.
IPSS = International Prostate Symptom Score.
[a] Low household income means an annual income less than 0.6 million NT dollars; averaged is between 0.6 and 1 million NT dollars; high is more than 1 million NT dollars.

had high operation risk including 13 with ASA scores of 3 and 8 who were on anticoagulant therapy, lower than TURP patients (39%, $p = 0.41$). Table 2 lists the major preoperative and operative outcomes. The HPS group had comparable results in four functional parameters versus TURP, and had significantly shorter hospitalization duration, less serum sodium and hemoglobin decrease, but longer operative time.

Fig. 1 shows the box plots of the adjusted IPSS improvement for the defined subgroup. In the subgroup of patients with younger age (age < 76 years), after adjustment for baseline IPSS, BMI, baseline prostate volume, education level and household income, the IPSS decrease for HPS and TURP was 14.9 and 11.8 ($p = 0.04$), respectively; and in the older subgroup it was 12.6 for HPS and 11.5 for TURP ($p = 0.13$). Men with higher BMI had better adjusted IPSS improvement after HPS (15.3 vs. 12.2, $p = 0.01$). Within the HPS group, younger patients had significantly greater adjusted IPSS improvement (15.5 vs. 12.4, $p = 0.007$; figure not shown).

The box plots of the adjusted QoL are presented in Fig. 2. Patients who were younger and had higher BMI had better QoL improvements after HPS versus TURP ($p = 0.04$ and 0.01, respectively).

Table 2 The major operative outcomes for the enrolled patients ($n = 125$) receiving treatment with 120W Greenlight HPS laser (HPS) or transurethral resection of the prostate (TURP).

	HPS	TURP	*p*
	n = 61	*n* = 64	
IPSS decrease	13.5 ± 5.00	12.2 ± 4.60	0.15
Quality of life score decrease	2.91 ± 0.91	2.60 ± 0.99	0.09
Postvoided residual change (mL)	169 ± 189	138 ± 185	0.39
Maximum uroflow change (mL/second)	7.58 ± 6.39	7.12 ± 4.49	0.71
Hospitalization duration (d)	3.54 ± 1.99	5.74 ± 1.84	<0.0001
Operation time (min)	148 ± 53.5	81.0 ± 29.5	<0.0001
Serum hemoglobin change (g/L)	0.80 ± 0.68	1.10 ± 0.69	0.002
Serum sodium change (mmol/L)	0.98 ± 1.56	1.99 ± 1.62	0.031

Numeric data are expressed as means ± SD and compared with the *t* test. Categorical data are expressed as numbers (percentage) and compared with the Chi-square test.
IPSS = International Prostate Symptom Score.

Discussion

Our results showed comparable functional outcomes including IPSS, QoL Qmax and PVR improvements between

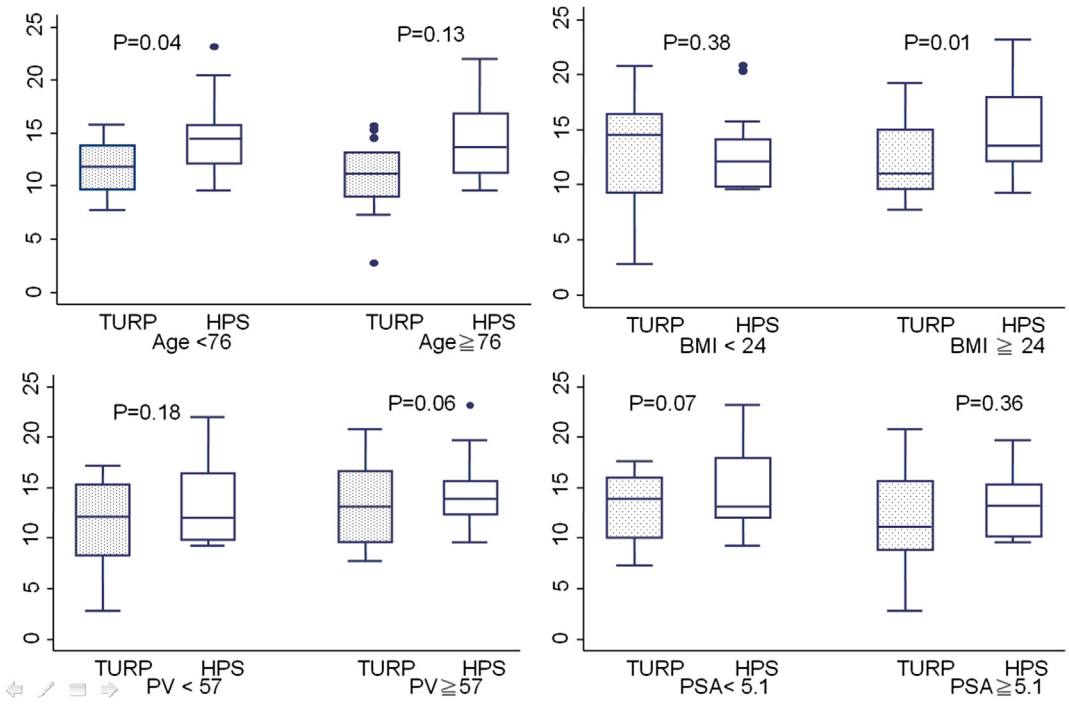

Figure 1 Box plots of the International Prostate Symptom Score (IPSS) improvements for the four patient subgroups, adjusted for baseline IPSS, age, body mass index (BMI), prostatic volume, educational level and annual income. Treatment with 120W Greenlight HPS laser (HPS) is compared with transurethral resection of the prostate (TURP).

HPS and TURP. IPSS decreased 70% (13.5 points) from baseline for the HPS group, which is similar to that reported in many published series.[6,13–15] Compared to TURP, HPS accounts for lower hemoglobin and electrolyte loss and adequate safety. Surgeons may recommend HPS for large prostate patients who can afford the cost of the procedure, especially men with a high-risk or moderate-to-severe condition with comorbidity. In the present

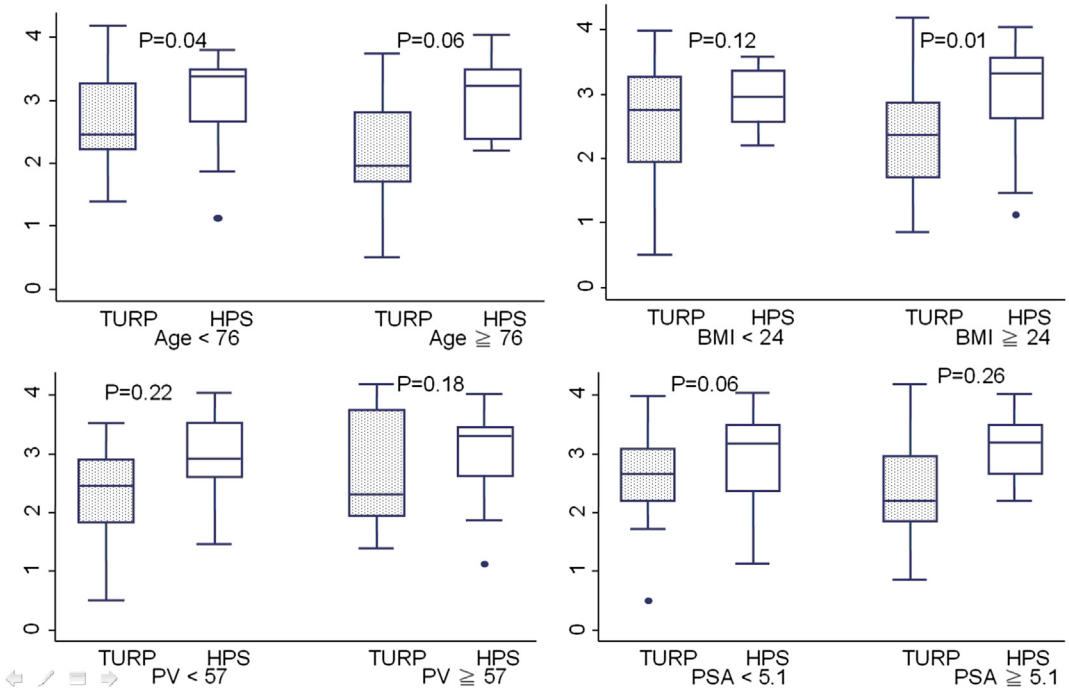

Figure 2 Box plots of the quality of life (QoL) improvements for the four patient subgroups, adjusted for baseline QoL, age, body mass index (BMI), prostatic volume, educational level and annual income. Treatment with 120W Greenlight HPS laser (HPS) is compared with transurethral resection of the prostate (TURP).

study, the HPS patients had significantly larger prostates, which may resulted in more adenoma volume reduction and insignificantly better IPSS and QoL improvements than TURP.

Because of the bloodless nature of the procedure and the use of saline irrigation during the HPS, surgeons have a clear operation field most of the time, even after a 3-hour surgery. No obvious bleeding or blood loss was noted in HPS men taking anticoagulants. Most operations were done by one experienced surgeon who had performed similar laser surgery in more than 20 cases for HPS, so the learning curve effects of the technique were minimized.[16,17]

We used several potential confounders, including age, BMI, baseline prostate volume, educational level and annual income as covariates for IPSS and QoL adjustment in subgroup analyses. The results showed that younger age and higher BMI will achieve better adjusted IPSS and QoL improvements after HPS, and TURP affords the smallest symptom score improvements in men with older age and lower BMI. Similar results were noted in recent reports of the CombAT study, which document more IPSS improvements in men who are younger and have higher BMI after prostate volume reduction therapy.[18]

The International Greenlight User (IGLU) study resulted in greater volume reduction in patients with larger prostate volume, but no IPSS decrease difference.[19] A previous study stated that TURP is superior to KTP laser in patients with larger prostates, although the latter has advantages with regard to intraoperative and perioperative safety.[11] Our results showed there is no IPSS and QoL decrease difference between the two procedures for larger and smaller PV groups.

Because laser therapy for symptomatic BPH is a relatively expensive procedure in Taiwan, it is important to predict which subgroups of patients are most likely to benefit from HPS so that unsuitable patients can be directed to alternative procedures. According to our results, primary physicians can make predictions according to BMI and age with ease and better suggestions can be given properly before referral.

One of the major limitations of this study is that the cost of laser therapy for symptomatic BPH is not covered by national insurance in Taiwan, so patients who cannot afford the procedure might be excluded from the HPS group, which may bias the results. However, we think the basic demographics of our patients truly reflect the current medical circumstance in Taiwan. Another limitation was lack of adenoma volume reduction and energy utilization data, which may provide more information to support the results. A randomized, double-blind, and placebo-controlled study in a larger sample size is warranted to clarify the effect of HPS and the patient subgroups that will benefit most from it.

The limitations of HPS in this study were the long operative time and high recatheterization rate (8.2% vs. 4.7% in TURP, data not shown). The vaporization-only technique requires more time, energy and laser fibers during the procedure,[20] especially in the first few cases. The depth of necrotic tissue (coagulation zone) after the vaporization-only technique in the present study may be larger than others such as the enucleation technique[21] and causes more temporary urinary retention rates after the Foley catheter is removed. We think that modern modified techniques such as vaporization—resection or enucleation methods[9,20,22] will improve these drawbacks in the future.

Conclusion

HPS offers adequate efficacy for BPH versus TURP and is advantageous with regards to operative safety. Younger patients (age < 76 years) and those with higher BMI (BMI ≥ 24) may achieve better symptom scores, and both IPSS and QoL improvements after HPS. Long-term follow-up is needed to evaluate the durability and possible morbidity for HPS.

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Author contributions: TK Yang had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. Study concept and design: TK Yang, Hsiao, Chien. Acquisition of data: TK Yang. Analysis and interpretation of data: TK Yang, HJ Yang, Chien. Drafting of the manuscript: TK Yang. Critical revision of the manuscript for important intellectual content: Hsiao, TK Yang, HJ Yang, Liao, Chiang, Chien. Statistical analysis: TK Yang, HJ Yang. Obtaining funding: none. Administrative, technical, or material support: TK Yang, HJ Yang, Hsiao. Supervision: Chien.

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